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GIS application in Tsunami and Flood Hazard Management of Coastal Region

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The vulnerability analysis for coastal region requires reliable and accurate data on topography, landform, elevation, distance from sea and tide heights to provide a realistic picture of vulnerability. In this line, remote sensing provides data on all aspects of coastal geography precise in time.

Tsunami and floods are more common in coastal lands. These lands are subjected to multitude of adverse factors both from terrestrial and ocean sides. It is clear that tsunami may pose a significant hazard in this vulnerable zone in terms of loss of life, destruction of property and damage to coastal infrastructure.

The tragic events of the Indian Ocean tsunami on 26 December 2004 tinted shortcomings in the response and alert systems for tsunami threat in India. Determining the likelihood of a disaster is a key component of any comprehensive hazard assessment. As a preventive measure, vulnerability analysis is essential to prevent these losses through planned preparatory measures. This augments disaster response operations by alerting emergency forces in risk susceptible area in time. Presently, no current detailed response plans for tsunami in India.

Indian scenario:

After 2004 tsunami, India looked on early warning systems for Indian Ocean for getting information on tsunami concurrently. This requires continuous monitoring of sea conditions for which we depends on foreign countries. This is a huge investment process. In addition to this, this information is not sufficient for emergency response because we don't know who is going to be affected in real if tsunami occurs in particular region because within a region, each site has differing vulnerability according to its local topography and geography. Vulnerability analysis fills this gap as it shows the vulnerability of different sites within a region. This enhances emergency response precisely in time without wasting time and resource.

India is the one of the leading country in remote sensing with lot of scientific expertise in the arena of GIS and natural resource management. But till initiative on development of vulnerability mapping for coastal regions of India is lacking. But there are few local level efforts were carried out in some part our country as a pilot scale research (Kumaraperumal, 2006). In this concern, there is a need for national level project on coastal vulnerability mapping to manage the natural hazards in coastal India.

Vulnerability mapping:

The vulnerability analysis for coastal region requires reliable and accurate data on topography, landform, elevation, distance from sea and tide heights to provide a realistic picture of vulnerability. In this line, remote sensing provides data on all aspects of coastal geography precise in time. GIS provides a mechanism to integrate different information such as spatial data, digital elevation, landform, topography and others (Sivasamy *et al.,* 1998) to display critical information during an emergency. This advantage of GIS can be exploited by many scientists (Greidanus *et al.*, 2004) in tsunami and flood (Vinu chandran *et al.,* 2006) hazard assessment. To date in India, this issue of vulnerability assessment is paid little attention though it cost less compared to huge investment on early warning systems.

Tsunami hazard mapping:

The methodology to assess tsunami risk is predominantly based on GIS computational modeling. The general methodology follows these key elements:

1. A possible zone of tsunami is assumed by considering the maximum distance by which tsunami waves can able to reach. In many cases it may be up to 2 km distance from seacoast.
2. The height and velocity of tsunami wave is assumed as maximum level.
3. Considering landform, elevation and distance from seacoast, vulnerability criterion is developed.
4. Through overlay and intersect analysis in GIS environment, tsunami susceptible area and its intensity will be worked out.
5. Finally hazard map will be developed by generating thematic maps on assigned vulnerability criteria.

This requires geographical map of coastal regions and data on elevation, which may be obtained from Survey of India, Indian Remote Sensing Agency or from foreign sources. A micro-level tsunami hazard map preparation worked out by RS and GIS center, TNAU is shown below (Fig. 1 & 2)

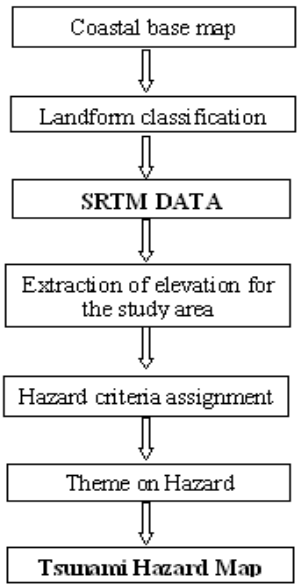

Fig. 1: Flow chart for the Tsunami hazard map preparation

Flood hazard mapping:

The assumption behind the flood hazard mapping is that all the lands below the flood height are liable to flood if they are continuously present without any upland interruption from the river breaching point. The location of dike failure will be worked from the local topography, elevation and previous flood incidents in an area. The RS&GIS Centre adopted the following methodology for the flood hazard map (Fig. 3) generation.

First, dike failure point is marked as starting cell and its elevation is noted. Flood height expected from this point is assumed. Considering this, cells are grouped based on certain elevation interval. The group of cells that falls below the defined elevation is recognized as flood liable if that group has connectivity with starting cell. For this purposes, topographic operator function in IDRISI package was used in conjunction with connectivity operator. The flood liable area is worked out as well as flood volume is calculated using elevation and cell area information in GIS environment.

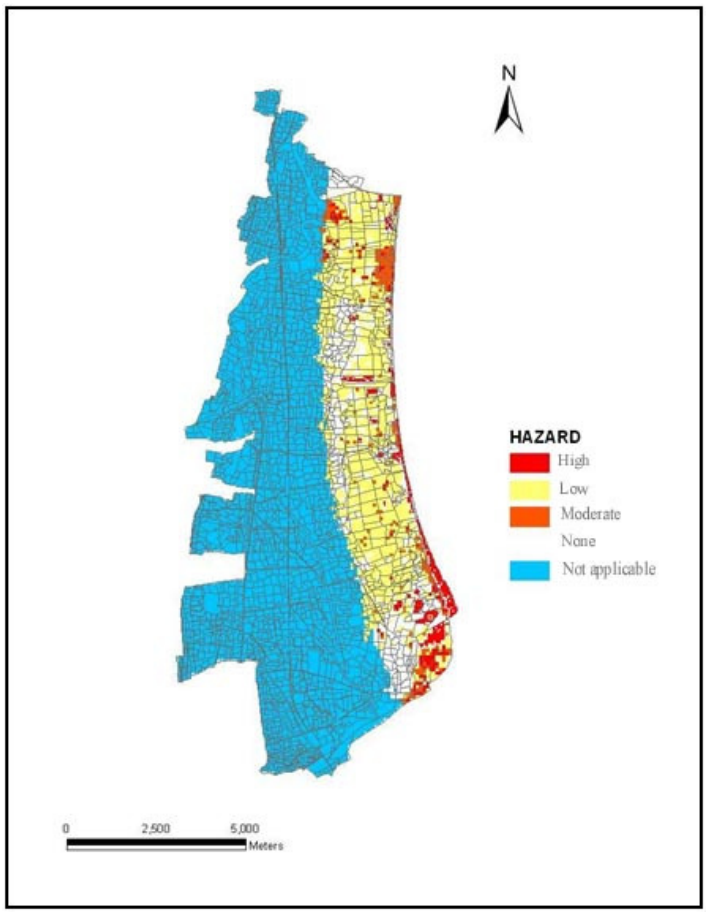

Fig. 2: Tsunami hazard map for the part of Cuddalore coastal region

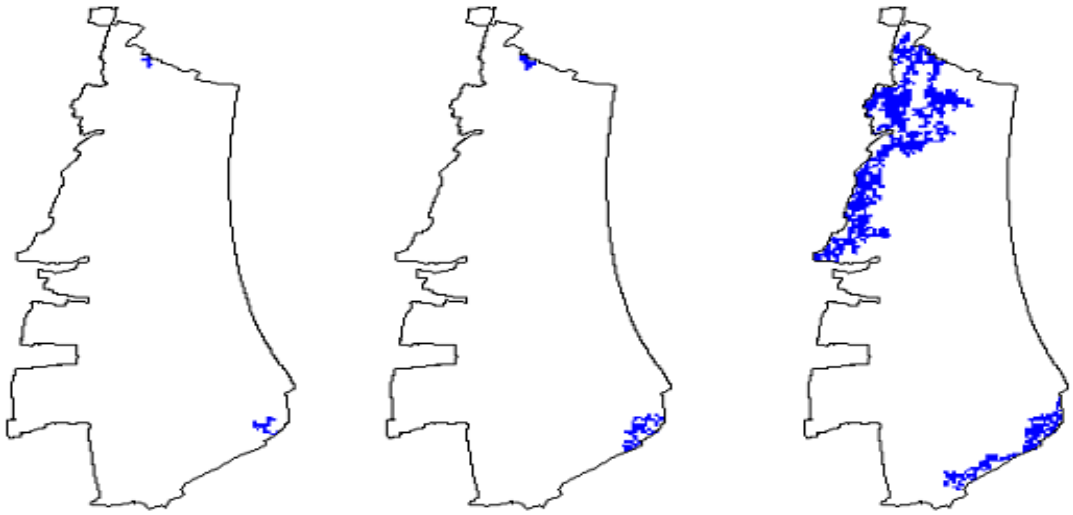

Fig. 3: Flood hazard map developed for 1, 2 and 3 m flood height for Uppanar river in cuddalore coastal region.

Conclusion:

This GIS based hazard mapping creates many avenues for emergency management. The above hazard mapping gives the following information and advantages:

- Identification of coastal areas liable to tsunami with its severity
- Identification of community in real crisis at the time of emergency
- Development of emergency management plan for in time crisis management
- Helps in creating awareness to local peoples and stake holders
- Facilitate local tsunami emergency response planning for local government
- Emergency managers and responders gets desired information for post tsunami hazard management

Thus this hazard mapping facilitates ready adaptation by planners and emergency managers for hazard management besides intending for educational and awareness programmes (Theilen-Willige, 2006). Also this assists evacuation strategy, rehabilitation, planning and damage assessment in the affected area (Brouder, 1994). This thoughtful GIS based preventive measure can take much of the panic and surprise out of emergencies and saves millions of human lives besides reducing the cost of disasters.

Suggested Readings:

Brouder, J.A.M. 1994. Flood study in the Meghna-Dhonagoda Polder, Bangladesh, *In:* Proceedings Asian Institute of Remote Sensing, Bangalore, India, 17–23 November.

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